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REPORT OF PROCEEDINGS

Conference on Deciduous Fruits

February 6-7. 1950

Conference was held at the Eastern Regional Research Laboratory with representatives of the deciduous fruit processing industry, growers associations, universities, State Agricultural Experiment Stations and the United States Department of Agriculture participating.

This report summarizes the discussions of the various speakers during the conference. If further details regarding any particular subject are desired, they may be obtained by writing to the person concerned. See the appended list for names and addresses.

Eastern Regional Research Laboratory
Bureau of Agricultural and Industrial Chemistry
Agricultural Research Administration
U. S. Department of Agriculture
Philadelphia 18, Pennsylvania

PROGRAM

Monday, February 6

10:00 a.m. Introductory Remarks — John R. Matchett, BAIC, USDA

1. EFFECT OF FIELD PRACTICES AND STORAGE ON QUALITY

Some factors affecting composition and quality of sour cherries	Fred H. Lewis Arendtsville Laboratory Pennsylvania State College State College, Pennsylvania
Influence of spray treatments on quality of red cherries	Roy E. Marshall Agricultural Experiment Sta. East Lansing, Michigan
Relation of storage maturity of apples to quality for freezing	J. S. Caldwell, BPISAE, USDA Beltsville, Maryland
Storage of fruits in relation to processing	R. M. Smock Agricultural Experiment Sta. Ithaca, New York

12:30 p.m. LUNCH

2:00 p.m.

2. FRUIT ESSENCES

Production of volatile fruit flavor concentrates	R. K. Eskew Eastern Regional Research Lab.
Some applications of fruit essences	Lyle L. Davis Agricultural Experiment Sta. Blacksburg, Virginia

3:30 p.m.

3. TOUR OF THE LABORATORY

Tuesday, February 7

9:30 a.m.

4. PROCESSING OF FRUITS

Preparation and utilization of fruit purees	R. R. Legault Western Regional Research Lab.
Sirup impregnation of apple slices for freezing	J. B. Wegener Food Processing Sta. TVA, Knoxville, Tennessee
Quality retention through dehydrofreezing	R. R. Legault Western Regional Research Lab.

Thermal inactivation of fruit enzymes in relation to processed products	Wm. B. Esselen, Jr. Agricultural Experiment Sta. Amherst, Massachusetts

12:30 p.m. LUNCH

2:00 p.m.

Apple juice and concentrates prepared with addition of Vitamin C	C. S. Pederson Agricultural Experiment Sta. Geneva, New York
Utilization of fruit and vegetable wastes	W. B. Van Arsdel Western Regional Research Lab.
Research needs in fruit processing	E. H. Pfahler Cherry Growers, Inc. Traverse City, Michigan

INTRODUCTORY REMARKS

by

J. R. Matchett, Bureau of Agricultural and Industrial Chemistry

Dr. Matchett outlined briefly the problems assigned to the four Regional Laboratories; deciduous fruits are under study at the Eastern (Philadelphia) and Western (Albany, California) Laboratories. At the Bureau's laboratory at Pullman, Washington, fruits of the Pacific northwest are under study, with emphasis on freestone peaches and pear waste. Non-deciduous fruits are under study at the Western Laboratory, and at Bureau field stations at Pasadena, California, Weslaco, Texas, and Winter Haven, Florida. At all these laboratories inquiries are welcome.

Dr. Matchett said that present trends in the fruit industry are increasing public demands for better quality products and for greater ease of preparation at home. As an illustration of a product which meets these demands, he cited frozen orange juice, and said that the development of this product could serve as an example for other fruits.

SOME FACTORS AFFECTING THE COMPOSITION AND QUALITY OF SOUR CHERRIES

by

F. H. Lewis, Pennsylvania State College

Relatively obvious factors affecting quality include bird picks, attached stems in picked fruit, dirt and leaves in crate, hail marks, plum curculio egg-laying scars and larvae in the fruit, cherry maggots, cherries discolored by sooty mold growing in aphid honeydew, off-flavor due to benzene hexachloride, brown rot, bitter rot, and Botrytis rot.

Factors affecting quality which are somewhat difficult to evaluate include the following: (1) cherry ring spot, which has no marked effect on fruit but reduces healthy foliage; (2) cherry yellows which causes a large reduction in yield with abnormally large cherries which may or may not be lower in solids than normal; (3) Alternaria rot which causes a flat side on the cherry and is difficult to sort out because of the tendency of the flat side to rest on the belt as the fruit passes the sorting workers; and (4) the tendency of young trees to bear small fruits which are low-grade because of size.

Major factors affecting fruit quality and composition include the following:

(1) The season or general weather conditions. Variations of 15 to 25 cherries per pound and 2 to 3 per cent in solids content between seasons are common. One important point is the rainfall in late June and July.

(2) Planting distance, tree size, and pruning as they affect the amount of weak wood in the tree and the amount of light that penetrates the trees. Small green or poorly-colored cherries on healthy trees have usually been due to these factors, complicated in some cases by frost injury to the ovaries and very heavy crops.

(3) Freezing injury to the fruit resulting in dead areas in the flesh and russeting of the surface.

(4) Partial or complete premature defoliation by leaf spot. Starting with healthy trees, the first year effects of defoliation have been large fruits with a light dull red color, flat and watery in taste, with a lower solids and acid content than normal. The effect depends upon the time and degree of defoliation. Unsprayed fruit from trees defoliated during and after harvest may be preferable to sprayed fruit.

Premature defoliation one year has a very great effect on the crop the following year through yield reduction, slow development of color until near harvest, then rapid and uneven color development, shriveling and drying during an abnormally short harvest period. We have been able to reduce this effect materially by using a relatively non-injurious organic fungicide containing nitrogen the season following defoliation.

(5) Spray Materials.

Size variations of 15 cherries per pound due to spray materials are common with 30 to 40 recorded but unusual. Crag Cherry Fungicide 341 and Phygon have caused little or no fruit dwarfing but may reduce size some when combined with lead arsenate and lime. Fermate and the Isothan group have shown a slight to moderate tendency to dwarf the fruit, with the tendency not evident except where rainfall is inadequate in late June and July. The proprietary coppers, lime sulfur, zinc and copper chromate compounds, and perhaps Zerlate and Dithane plus Zinc-lime cause moderate fruit dwarfing. Bordeaux mixture causes too much dwarfing to be tolerated. These dwarfing effects vary in degree with climate.

Solids content variations of 2% with different spray materials are common and 6% rare. Solids content has been highest with Bordo; lower with the proprietary copper group, and lowest with the organics which do not dwarf the fruit. The percentage solids and number of cherries per pound show a positive correlation, but differences exist after correction for fruit size.

The percentage acid in the cherries varies with the spray material and shows a positive correlation with the number of cherries per pound.

The weight of pits per pound of fruit has varied from about 6.5 to 8.5% with the smallest fruits having the highest pit weights. Differences in weights of individual pits have not been significant.

Fruit color varies markedly with the spray material, and has been lightest with Crag 341 and darkest with the coppers.

These variations have been evident, in general, regardless of the time the data were taken although the differences may become larger as the harvest progresses.

Work on controlling cut-out weights and solids content in canned cherries has been done in commercial canneries here since 1933 or 1934. Greenleaf's work in 1936 clarified the situation so far as solids in the can are concerned. He also showed that cut-out weights were increased by increasing the weight of fresh fruit per can in a water pack. His increased cut-out weight averaged about 76% the weight of fresh fruit added above a base figure of 12 to 14 ounces for No. 2 cans.

One laboratory and 2 cannery tests with fruits sprayed with different materials have shown an increased drained weight and cut-out Brix with increased solids content of the fresh fruit. In 1949, addition of 1500 p.p.m. Fermate directly to the cans caused the cherries to turn brown with a very offensive odor. There was no off-flavor or color in cherries sprayed 5 times with Fermate at 1-1/2 and 2 lbs. and run through the regular factory procedure.

It should be remembered that calculations of increased factory returns with high solids cannot be based on the assumption that the fruits are otherwise equal. High solids content obtained with copper sprays means in this area that the fruits will be small, the losses in pitting greater, the color more variable, the labor cost greater because of extra sorting required, the total capacity of the plant lower, and the growers dissatisfied. The grower would get a lower yield, a lower grade of fruit, and higher picking costs.

We need to know (1) whether or not various spray residues can be removed, and (2) whether normal amounts (1 to 30 or 40 p.p.m.) of the pesticides are directly responsible for undesirable qualities in the product. Beyond these points, the problem is one for good judgment in weighing the good points of a spray material against the bad.

Discussion

Question by Dr. R. T. Whittenberger: Did you have any trouble growing cherries without any spray treatment at all?

Answer: No I did not, I never lost a tree.

INFLUENCE OF SPRAY TREATMENTS ON QUALITY OF RED CHERRIES

by

Roy E. Marshall, Michigan Agricultural Experiment Station

In 1947 the Michigan processors of tart red cherries encountered difficulty in processing fruit which had been treated with wax emulsion sprays. In 1948 studies at Michigan State College showed that cherries sprayed with wax, and also those sprayed with Ferbam, were larger, lighter and less uniform in color, lower in soluble solids, and gave lower drained weights after processing than did the standard copper-sprayed cherries.

Studies in 1949, however, did not confirm entirely the results of the previous season. There was no correlation between the drained weight of the processed cherries and the soluble solids content of the differently-sprayed fresh fruit. Likewise, there was no correlation between the spray treatments and the color of the processed fruit, or between the spray treatments and the pitting characteristics of the cherries. The texture (or toughness) of the canned cherries, as measured by the tenderometer, was not affected by the different spray treatments.

The size and the soluble solids content of the fresh fruit, however, were influenced by the spray treatments (Tables 1 and 2). The copper sprayed

Table 1. Effect of Sprays on Size of Cherries

Spray	*Grams per 100 fruits		
	(1) without wax	(2) without wax	(3) with wax
Copper	362	369	394
Ferbam	390	394	406
Nabam	395	390	412

* Column 1 is the average for 7 orchards. Columns 2 and 3 are the averages for 4 orchards and are comparable with each other.

Table 2. Effect of Sprays on Soluble Solids Content of Cherries

Spray	**Percent of Soluble Solids		
	(1) without wax	(2) without wax	(3) with wax
Copper	16.3	15.5	14.1
Ferbam	14.6	14.1	12.9
Nabam	14.7	14.2	13.9

** Column 1 is the average for 7 orchards. Columns 2 and 3 are the averages for 4 orchards.

cherries were the smallest in size and the highest in soluble solids content. Spraying the cherries with wax increased their size and decreased their soluble solids content.

In these studies the variously sprayed cherries were harvested at the same time. It became apparent, however, that the different spray treatments affected the rate of maturation of the cherries. Copper sprayed fruit matured at a comparatively early date, whereas cherried sprayed with Ferbam, Nabam, and wax emulsions were comparatively slow to mature and often were picked at an immature stage. This may account in part for the lighter color and lower soluble solids content of the latter cherries. Additional studies are contemplated in which the variously sprayed cherries will be picked at approximately the same stage of maturity.

Soaking fresh cherries in tap water at 57° F decreased their soluble solids and acid content and decreased the intensity of color of the canned product. The decrease was almost linear with time from 0 to 48 hours of soaking. The texture of canned cherries was made increasingly more tough, as indicated by tenderometer measurements, by prolonged soaking of the fresh fruit. With mature cherries the juice loss during pitting was not much affected by the

period of soaking. The average juice loss was about 10.5%. With immature cherries, the loss during pitting decreased with the length of the soaking period. The initial loss from the immature cherries (not soaked), however, was considerably greater than that from mature cherries.

Discussion

J. Oyler: What effect does the temperature of the water used for soaking have on the cherries?

Answer: Cherries which were quickly chilled, pitted as well as those which had been soaked for a long period. Lowering the temperature of cherries, without soaking them, increased their firmness and prevented losses in soluble solids. Maximum firmness, however, was obtained by soaking at a low temperature. Unbruised cherries showed some evidences of cracking after being soaked for 12 to 15 hours in distilled water. On the other hand, bruised cherries swelled only slightly and showed a minimum amount of cracking.

Question: What effect does soaking have on spray residues?

Answer: No study of this subject was made. The quantities of spray residues remaining on Michigan-grown cherries during a normal growing season are insignificant.

P. A. Wells: What is the effect of soaking cherries in a dilute solution of calcium salt?

Answer: Soaking cherries in a dilute calcium chloride solution resulted in an increased firmness or toughness of the canned product. The firming action of calcium ion is utilizied in most processing plants, owing to the natural hardness of processing water in Michigan.

Question: Why are soaked cherries lower in soluble solids content?

Answer: During soaking, small quantities of soluble solids continuously leach out and are lost in the soaking water. In addition, especially in unbruised or in slightly bruised fruit, water enters the cherry tissues and dilutes the soluble solids.

L. L. Davis: How was the color of the cherries determined?

Answer: Liquid from the canned cherries was filtered and diluted fivefold with distilled water. The percent transmission was then determined by means of a Coleman Universal Spectrophotometer at 440 mu set to read 100% transmission with distilled water. No instrumental measurements of color were made on fresh whole cherries.

RELATION OF STORAGE MATURITY OF APPLES TO QUALITY FOR FREEZING

by
Joseph S. Caldwell, Bureau of Plant Industry,
Soils and Agricultural Engineering

The primary purpose of the work, which has been in progress three years, was to follow the changes in quality of the material used over its entire storage life by making successive packs at intervals from harvest to final breakdown. Nineteen of the more important commercial varieties were employed; for ten of these, fruit was obtained from two or three of the states of New York, Pennsylvania, Michigan, Massachusetts, Ohio, Maryland and Virginia, in the others, from Maryland or Virginia only. All fruit was placed in 32°F storage immediately after harvest or upon receipt. A portion of each lot was frozen immediately after determination of its stage of ripeness by means of the U. S. Department of Agriculture (Magness Taylor) pressure tester. At intervals thereafter, successive portions of each lot were transferred to 70° F storage, ripened to a predetermined pressure test, and packed. This procedure gave 4 to 6 successive packs differing by 2-3 pounds in pressure test and extending from picking ripeness (15-18 pounds) down to extreme softness (7-8 pounds). Comparisons of color, texture, flavor, and overall suitability between varieties can consequently be made at like stages of ripeness as determined by pressure tests. Packs were made with a variety of treatments with firming agents and anti-oxidants and also with no treatment whatever. These last gave information in regard to discoloration, fragmentation, and "mushing" and flavor at each stage of ripening, and consequently indicated the need for corrective treatments and the degree of their effectiveness.

A. Darkening. For these tests packs were made without any treatment whatever except addition of 50% sirup to fill interspaces. The following varieties were of acceptable color at all stages of maturity when so packed: Jonathan, Grimes, Yellow Newtown, Winesap, Baldwin (N. Y.), Cortland (Mass.). The following varieties were acceptable when packed in the early (firm) stages, but darkened when packed in the more mature stages: Northern Spy (N.Y.), Golden Delicious. The following varieties were acceptable only when packed in mature state: York Imperial (Va.), Rome Beauty, Cortland (N.Y.), Baldwin (Md.), Stayman Winesap. The following varieties darkened to an unacceptable degree at all stages: Lowry, McIntosh, Rhode Island Greening, Northern Spy (Mich.).

Effect of Ascorbic Acid: Packs made with the addition of ascorbic acid (1 part in 2500) to the sirup used in packing were compared with controls. The least improvement in color (about 1 point on a scale of 10) was noted in freshly-picked firm fruit. With advanced maturity, improvement amounted to 1.5 to 2.5 points. Acceptable but not necessarily wholly satisfactory color was maintained with all varieties at all stages with ascorbic acid in the proportion of 1 to 2500.

Effect of SO_2: Immersion of fruit in sulfite solutions of 500 to 2500 parts per million for various periods caused improvements in color, but had adverse effects on flavor. The addition of 25-100 p.p.m. to the sirup used in the pack, followed by immediate sealing, improved color without perceptible bad tastes, but this effect probably could not be obtained in a dry pack.

B. Flavor: The flavor improved, in general with increasing maturity. This effect was most marked with York Imperial and locally grown Baldwin, Jonathan, Grimes and Rhode Island Greening. On the other hand, Northern Spy, Yellow Newtown, Baldwin (N.Y.) and Winesap were good in flavor at pressure tests of 18-15 pounds and showed little change in flavor as they softened.

C. Fragmentation: This is a measure of the breaking up and disintegration (mushing up) of the fruit during cooking. It increases, in general, with the degree of maturity. York Imperial, Yellow Newtown, Baldwin (Md.) and Jonathan do not disintegrate seriously even when quite soft, but McIntosh and Cortland, as maturity increased, showed severe fragmentation. The addition of calcium salts was of little benefit with hard fruit. In the middle range (13 to 9 pounds pressure test) it was of advantage with varieties which showed much disintegration at that stage, but in effective concentrations the taste was often noticeable. The same was true in the case of very soft fruit, where high concentrations were necessary resulting in objectionable flavors.

The outstanding fact brought out in the work is the enormous difference in resistance to disintegration between varieties that are at an identical stage in ripening as measured by pressure tests. Further investigation of the cause of such difference is urgently needed.

Discussion

J. B. Wegener: What period of time is represented by the change in pressure reading from, say 15 to 7 pounds?

Answer: At 32°, the time might vary from 6 to 10 weeks for the softer to about 5 to 8 months for the harder fruit. At 70°, 3 to 5 weeks.

Question: How did Rhode Island Greening come out in the disintegration tests?

Answer: It held up well at pressure of 18 to 12 pounds but disintegration increased markedly with softening below 12 pounds.

Dr. C. S. Pedersen: How was the ascorbic acid added?

Answer: It was added in the syrup.

Dr. C. H. Hills: How does the temperature of ripening affect the flavor?

Answer: Apples ripened at 70° have a better flavor than those ripened at the same pressure value in cold storage.

Dr. D. B. Hand: Have you had any success with the use of a pressure tester to measure the firmness of the processed fruit?

Answer: We have not attempted to use such a device.

Dr. R. R. Legault: We have used the tenderometer with good success on processed fruit.

Dr. G. L. Baker: How were your flavor tests carried out?

Answer: We had a panel of 6 to 10 members from our own organization. Results were checked by repetition for a considerable part of the material.

Dr. L. L. Davis: Have you tried the effect of salt solutions on color improvement?

Answer: In our experience, it preserves color fairly well until thawing begins, but considerable darkening may occur in thawing and baking. For varieties prone to discolor, soaking for a period sufficient to control may give a salty taste to the pie or sauce.

STORAGE OF FRUITS IN RELATION TO PROCESSING

by

R. M. Smock, New York Agricultural Experiment Station - Ithaca

Dr. Smock stated that rather than outline temperature and humidity requirements or lengths of storage periods for specific fruits, an outline of the principles affecting storage would be developed.

The general factors affecting the ripeness of fruits coming out of storage and arriving at the processing plants were outlined as follows:

1. Respiration rate.

    (a) The respiration of a given fruit at a specific temperature will vary with time. (A plot showing respiration rate on the vertical axis and elapsed time on the horizontal axis, and a continuous curve having two inflection points was shown). Changes in respiration rate are an indication of ripening.

2. Field or Orchard Factors.

    (a) Season

    (b) Climate

    (c) Culture

        (1) Use of Nitrogen fertilizers stimulates respiration during storage.

        (2) Cultivation, etc.

(d) Spraying

(1) Fungicides - Use of mercurics results in delayed maturity or slower ripening in storage.

(2) Insecticides - no information available as yet.

(3) Hormones - stimulate respiration.

(e) Soils

(f) Maturity - or time of picking.

(g) Mechanical damage - causes higher respiration rate resulting in more rapid deterioration on storage.

3. Storage Conditions

(a) Temperature

The temperature coefficient of respiration for apples = 2.0 - 2.5
" " " " " " peaches = 3.0 - 3.5

The comparison of the temperature coefficients of respiration when the age factor is considered (see Curve 1,a).
The specification of the proper storage temperature for a given fruit should include, how rapidly heat should be removed to attain that temperature.

(b) Ripening volatiles

(1) Ethylene C_2H_4

(a) The effect of unripe fruit on ripe fruit is measurable by C_2H_4.

(b) Air purification to remove volatiles will prevent ripening.

(c) Activated carbon removes some ethylene but not all.

(2) Oxygen level.

(a) Removal of oxygen slows ripening.

(3) Carbon dioxide.

(a) Increasing the carbon dioxide in the storage atmosphere slows ripening.

Discussion

Question: Will you repeat your remarks concerning carbon dioxide?

Answer: High carbon dioxide concentration slows down respiration rate and ripening.

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6\ CO_2 + 6\ H_2O + \text{Heat}$$

Dr. R. Legault: Does raising the storage temperature and cutting down on CO_2 improve the rate of ripening of Pippen apples?

How high a temperature can be attained in ripening?

Answer: Some apples can not in some localities stand high temperatures, but there is an optimum temperature for each locality and variety. High temperatures sometime actually slow down ripening.

Question: Is ripening due to color or texture changes?

Answer: Due to texture changes.

Dr. P. A. Wells: Ripeness was found to be an important factor in the essence work of this Laboratory, affecting the quality of essences obtained. Dr. J. W. White of this Laboratory has identified 26 volatile compounds in ripe apples.

PRODUCTION OF VOLATILE FRUIT FLAVOR CONCENTRATES

by

R. K. Eskew - Eastern Regional Research Laboratory

Mention was made of early attempts to recover the volatile flavor of fruit juices in concentrated form by vacuum evaporation, condensing the vapors at low temperature. The inherently high losses characteristic of vacuum evaporation in contrast to operating at atmospheric pressure were given as the reason for Milleville and Griffin's designing a unit to operate at atmospheric pressure. This was reported to be the first successful apparatus for recovering in concentrated unaltered form the volatile flavors of apple juice. This first apparatus would not have been a commercial success because of excessive fouling in the superheater. This was overcome by substitution of a rapid atmospheric evaporator at the suggestion of G. W. M. Phillips. Industrial acceptance of the new process was enthusiastic until dampened by the alcohol tax. With repeal of the tax in September 1949, industrial production of apple and other fruit essences by this process has been resumed. Kiplinger prophesies that volatile flavor recovery will be an important industrial development of the next decade.

Using the principles developed for apple essence recovery, essences were prepared at the Eastern Regional Research Laboratory and in cooperation with the Virginia State Experiment Station from the juices of several varieties of grapes, blackberries, strawberries, peaches, quinces, huckleberries and other fruits.

A description was given of a new portable essence unit developed at the Laboratory which should be adaptable with improved efficiency to the recovery of flavors from the juices of a wide variety of fruits. This unit uses a preheater ahead of the rapid evaporator to minimize surging and to

reduce the time-temperature effect during vaporization. A more efficient means of scrubbing the vent gases to replace scrubbing with chilled essence was described.

The Laboratory's work on essence recovery is now being directed largely to obtaining in essence form the volatile flavors given off during the conventional manufacture of jams, jellies, preserves and the like. An apparatus used for accomplishing this from atmospheric cooking kettles was described. Some of the problems entailed in recovering it from high vacuum evaporating systems were pointed out.

SOME APPLICATIONS OF FRUIT ESSENCES

by

Lyle L. Davis - Virginia Agricultural Experiment Station

All of the experimental evidence to date indicates that the addition of fruit essences to their respective products enhance the flavor, providing the essences are added at the proper time. If the essences are added to the processed product while the temperature is too high, the essences readily volatilize and are lost. When possible to add the essence to the processed product at a temperature of 180° Fahrenheit, no loss in essence will occur. It is also possible to add the essence to boiling products in such a way that no losses occur, if the cans or bottles are sealed immediately.

It seems unnecessary to point out parts for discussion that were emphasized in the article by Griffin, Davis, Eisenhardt and Heller, under the title "New Progress in Fruit Flavor Recovery", published in Food Industries, Volume 21, November, 1949. I do wish to emphasize, however, that the natural fruit essence, when added to jelly, jam, preserves, puree, sirup, juice concentrates, sauce, baked and fried apples, has resulted in improved flavor. One should remember that with fruit essences it is possible to secure too much flavor. When the essence is added in a concentration somewhat greater than occurs in the natural fruit, the product may be less desirable to consumers. Our experience to date indicates that addition of essence somewhat less than that which normally occurs in the fruit, to approximately equal concentration, is most often acceptable. Anything that enhances the flavor of certain fruit products may make that product less desirable to certain consumers. For example, there are individuals who do not like the fresh flavor of blueberries. Consequently, when blueberry essences are added to jelly or sirup, it becomes less tasty.

Each fruit essence retains the characteristics of the fresh fruit. That is, strawberry essence tastes in the product only like strawberries not like blackberry or some other fruit. Likewise, even the variety retains its characteristics in the essence. Thus, by blending the essence of certain varieties of fruits, it is possible to secure very unusual and tasty processed products. For example, when essence of certain more desirable varieties of apples is added to some sauce, to some baked apples, and to some fried apples, there is an enrichment of flavor. York Imperial and Rome Beauty apples, baked or fried, can be improved in flavor if

Stayman-Winesap apple essence is added just before the cans are closed. Likewise, the addition of Golden Delicious essence added to Ben Davis fried apples improves the flavor.

Experiments by Dr. C. C. Flora and the writer, which will be reported in the near future under the title "The Use of Peach and Strawberry Essence in Ice Cream", indicate that it is possible, through the use of essence, to add roughly the equivalent of 1/4 to 1/2 pound of strawberry juice or peach juice per gallon of finished ice cream, without diluting the ice cream to a point where it is below the standard of butter fat and total solids. Our tests indicate that peach ice cream tastes like peaches, and that possibly the best flavor for strawberry ice cream as well, is secured from the canned product, to which the essence has been added as the ice cream is manufactured. Imagine for a moment, if you will, strawberry ice cream so strong in strawberries that the aroma of strawberries fills your mouth and nasal passages with every bite. This is possible with strawberry essence added to the mix in strawberry ice cream manufacture.

In closing, I should like to point out that in fruit essences we have the means for increasing the natural fruit flavor of any commercial processed fruit product. That through the use of essence, you can increase the flavor to a point where it may be unacceptable to the consumer, and that through the blending of essences, or of essences and different products, unusual flavors of tempting delicacy and armoa may be had. Further, let me point out, while horseradish is not a fruit, yet in my laboratory we have recovered the essence of this elusive product. It is a very potent material. I believe, that it, like the fruit essences, may have wide use. (A sample of horseradish essence was circulated to the audience).

Discussion

(Papers of R. K. Eskew and L. L. Davis)

E. Friedman:	Has any progress been made in comparing 100 fold essences of various manufacturers, for strength?
Answer: (R. K. Eskew)	The fold of essence depends in part on the losses from the recovery system, which vary with different manufacturers. No success has been achieved in making the comparison.
Question:	Will the variety of grapes used to make essence affect the strength of essence?
Answer: (Dr. L. L. Davis)	We have made 100 fold essence from four different varieties of grapes at Blacksburg, Virginia and found all to be of different strengths.
Dr. J. S. Caldwell:	Since there are about 26 different compounds in essence, why not make analyses for individual compounds.
Answer: (Dr. P. A. Wells)	The analyses are too time consuming.

Dr. D. B. Hand: Have you any information on how second essence differs from first essence?

Answer:
(R. K. Eskew) We have no chemical analyses on the two essences, but the second essence is weaker and less characteristic than the first essence.

PREPARATION AND UTILIZATION OF FRUIT PUREES
by
R. R. Legault - Western Regional Research Laboratory

Purees are excellent means of utilizing over-ripe fruit which could not be otherwise processed. Manufacturers in the west have incorporated fruit purees in ice cream, beverages and in baby foods.

Interest in fruit purees dates back as early as 1927 when Cruess at the University of California published a paper on the Use of Purees for Manufacture of Ice Cream. It was found that with fruits such as berries a cold puree could be prepared. However, with fruits which tended to darken, boiling was necessary, and the proportion of four parts of fruit to one part of sugar was required.

In 1928 Fellers at the University of Massachusetts published data on purees and he stated that flavor retention was no better in crushed fruit than in whole fruit.

In England, Potter published a paper in 1933 in which he discussed the use of SO_2 for purees held in cold storage.

In his work on Storage of Frozen Purees Tressler found that there was better retention of ascorbic acid when sugar was incorporated into the puree prior to freezing. In 1942 Tressler recommended the use of a mixture of pectin, sugar and fruit puree in the manufacture of ribbon ice cream. However, he suggested that the use of equipment which beat air into the puree be discontinued in that ascorbic acid was destroyed. Deaeration after pureeing was recommended. A puree with a solids content 10% higher than that of the ice cream mix was suggested.

In 1944 Sorber and Loeffler at the Western Regional Research Laboratory developed a Velva Fruit dessert, the texture of which is similar to ice cream though it contains no milk solids. Velva Fruit contains about 63% fruit puree, 27% sugar, 10% water and 0.5% gelatin. This formula is suitable for tart fruits. For best results, blander fruits require addition of about 0.2% of an acid, such as citric. Several modifications of Velva Fruit have been made, in one of which heat processed fruit is used. It was also found that apples, which are relatively cheap, can be incorporated into the formula for example, an apple-berry combination can be used.

Another product developed at the Western Regional Research Laboratory is a cold process fruit spread which has a solids content of 56 to 57%. The

puree is combined with pectin and sugar in a manner such that no heating is required. There is no loss of flavor through volatilization. Gel formation occurs in 12 to 24 hours at which time it is stored at freezing temperatures. After thawing the spread can be kept satisfactorily in the refrigerator for long periods of time.

In 1946 Loeffler demonstrated the effect of sugars in ascorbic acid retention in raspberries and strawberries. However, it is questionable as to whether there is a direct protection or whether the effect is due to decrease in solubility of O_2 as a result of the addition of sugar. In more recent work on changes of flavor in fruit purees, it has been found that sugar did not protect against flavor changes.

In the preparation of purees the inactivation of the polyphenolase is of great importance. The method used by Western Research Laboratory workers (Joslyn and Pouting) for determination of polyphenolase activity has been published in the Archives of Biochemistry, 1948.

It was determined that as temperature was increased time required for inactivation of the enzyme decreased or when temperature was decreased time required for inactivation increased. The time-temperature relationship for inactivation of polyphenolase depends largely on the pH of the medium. Apricots show a large pH shift (about 0.4 pH unit) when heated, also when frozen and thawed. The pH at which purees show maximum heat stability varies from 3.9 to 6.2 for various fruits. The time-temperature relationships found for various fruits are shown in the following table.

Time-Temperature Relationships for Essentially
Complete Inactivation of the Enzymes of Various Fruits

Fruit	Temperature °C Required for Various Times			
	Time in Seconds			
	9	24	60	120
G. Apples	80	75	73	70
B. Pears	90	87	86	83
E. Peaches	82	76	75	72
B. Apricots	92	--	83	
C. Grapes	82	80		

Discussion

Dr. C. H. Hills: Is the enzyme the same in each variety of fruits?

Answer: Fundamental studies are being made and at present it is not known whether the enzyme is the same in all fruits or whether they differ.

Dr. C. H. Hills: Since optimum pHs for maximum heat stability differ for the various fruits would it not seem that the enzyme is different?

Answer: Biochemists feel that there is a possible difference in the enzyme.

R. K. Eskew: Are there variations in samples of the same fruit?

Answer: There are variations in pH in samples of the same fruit and in the data presented, a range of results was reported.

Dr. D. B. Hand: Does the enzyme recover its activity like peroxidase?

Answer: Purees were frozen and kept at 0° C for 1-1/2 years and when defrosted did not turn brown on standing for several hours.

G. W. M. Phillips: Is there less flavor loss by treating at higher temperatures for shorter periods of time or with lower temperatures for longer time periods?

Answer: We could not tell.

Question: What is the character of the flavor change?

Answer: Flavor is more acid or tart after heating.

Dr. C. W. Culpepper: Would metallic salts like iron affect flavor of the puree?

Answer: Iron contamination causes difficulty.

Dr. P. A. Wells: Have studies been made on metal deactivators like citric acid.

Answer: No.

SIRUP IMPREGNATION OF APPLE SLICES FOR FREEZING

by

John B. Wegener - Tennessee Valley Authority

In the canning and freezing of apple slices it is necessary to control the enzymatic reactions (browning) on the color in some manner. The two most commonly used methods are steam blanch and sulphite treatment. The first method leaches out the flavor and breaks down the texture, and the second method affects the flavor and results in corrosive by-products when the slices are used in baking. Therefore, research was conducted and a more satisfactory method was perfected. This method subjects the apple slices

to a 26-inch vacuum for 30 minutes, while submerged in a 30% sucrose solution containing 0.1% ascorbic acid and 0.1% citric acid (by weight of sirup). This treatment was compared with another vacuum method (used commercially for a number of years), requiring a 5% sodium chloride solution containing 1% citric acid. The vacuumizing solution penetrates to the center of the slices arresting the enzymatic (browning) reactions without materially affecting the flavor and texture. This method has been successfully used by commercial plants in this area for the past 2 or 3 seasons.

It was noted in general that both sirup and brine vacuumizing methods yielded a finished product of bright, typical color and a slightly translucent appearance. The texture of the brine treated slices was more firm than that of the sirup treated samples, and they tasted slightly salty.

The sirup treatment gave a better flavored product, but it cost 2 or 3 cents more per pound to produce.

The addition of calcium salts has been found to have beneficial effect on the texture of soft storage apples used for canning. The addition of calcium salts to the vacuumizing baths of the two methods mentioned above did not have a beneficial effect on the texture of soft apples used for freezing, even though a calcium pickup was noted in the slices.

Discussion

Question: A question was asked concerning the method used for the ascorbic acid analyses.

Answer: The dye titration method. Dr. R. R. Legault remarked that the dye titration method must be modified to eliminate the effect of reductones. Mr. H. C. Aitken recommended the Robinson and Stotz method for this purpose.

Question: Why does the ascorbic acid method of preserving color in frozen apple slices increase the cost by 2 or 3 cents per pound?

Answer: Mr. Wegener pointed out that most of the increased cost was due to the cost of the sirup rather than the ascorbic acid. The cost figure was based on a comparison with the method using a brine consisting of 4% NaCl plus 1% citric acid.

QUALITY RETENTION THROUGH DEHYDROFREEZING

by

R. R. Legault - Western Regional Research Laboratory

Dehydrofreezing, a newly-developed method of food preservation, is a combination of partial dehydration with freezing. It takes advantage of the fact that the early stages of dehydration are effected easily and

efficiently and with a minimum of adverse change in the fruit. When fruit is air dried, the weight loss and the volume loss are approximately equivalent up to about 60%. Beyond that point, the volume decreases more slowly, resulting in less advantage from the standpoint of packing efficiency. Moreover, the last stages of dehydration are accomplished with difficulty and involve alterations in color, flavor, texture, and ease of reconstitution. Dehydrofreezing therefore has most of the advantages of dehydration, and avoids most of the disadvantages.

The following procedure is used in the case of apples: The fruit is peeled, cored and sliced. The slices are dipped for one minute in a solution of free sulfurous acid. Upon heating in the drier, the diffusion of the SO_2 into the center of the slices takes place readily, and the excess gas is driven off. The SO_2 residue amounts to no more than fifty parts per million on the basis of the reconstituted fruit. The drying is carried out at atmospheric pressure at a temperature below 200°. The wet-bulb temperature rises to about 130°. The appearance of the slices is good. The partially dehydrated slices are packed directly into packages for freezing. Dehydrofrozen apples may be reconstituted by adding hot water, which defrosts and reconstitutes them at the same time.

The apples must be processed at the proper state of maturity. The latitude in this respect varies with the variety, and is especially critical in the case of Gravenstein. Delicious, Winesap, Pippin, Rome Beauty, Cortland and Baldwin apples have been tested. In general, varieties suitable for canning have been found suitable for dehydrofreezing.

Apricots are well adapted to dehydrofreezing, and the product is excellent for pies. The partially dehydrated slices are more flexible than in the case of apples, so that it is possible to pack the equivalent of sixty pounds of fresh fruit in a thirty-pound can.

Peaches may be processed in the same manner, but in the case of freestone peaches, difficulty is encountered with the slices sticking to the drying tray. This may be prevented by giving the fruit a gently tumbling action during the drying.

Fruit processed by dehydrofreezing may be kept for several days after defrosting. Its chief outlet appears to be in the field of commercial pie baking.

Discussion

R. K. Eskew: What is the moisture content of the dehydrated fruit before freezing?

Answer: That will vary with the solids content of the raw fruit. We aim for a fifty percent reduction in weight as an overall average.

Dr. R. Marshall: Are dehydrofrozen fruits in commercial production?

Answer: Not as yet.

G. W. M. Phillips: Is the inactivation of the enzymes by SO_2 carried out without the aid of heat?

Answer: The action of the SO_2 does not involve any heating effect.

Dr. C. H. Hills: I believe that the action of SO_2 is not essentially an inactivation of the enzymes, but only an inhibition of the enzymatic browning reaction.

Dr. G. L. Baker: Have you tried freezing the slices before packing them into the cans.

Answer: Yes, but following that procedure fewer slices can be put in the container.

Dr. L. L. Davis: Did you use a batch drier or a continuous drier?

Answer: So far we have used only batch drying.

Question: How long a lag is there before the wet-bulb temperature rises to the level point?

Answer: (A. H. Brown) About 5 to 8 minutes.

Dr. J. Oyler: How will dehydrofrozen apples compare in general with canned slices?

Answer: That depends greatly on how the canned slices are prepared. I believe that the bakers will consider dehydrofrozen slices very satisfactory. As to flavor differences, I think it is largely a matter of individual preference.

THERMAL INACTIVATION OF FRUIT ENZYMES IN RELATION TO PROCESSED PRODUCTS

by

W. B. Esselen, Jr. - Massachusetts Agricultural Experiment Station

The adverse effects of enzymes upon the quality of fruits and vegetables, under certain conditions have long been recognized. Although considerable work has been done on the inactivation of enzyme systems of fruits and vegetables to be dehydrated or frozen, comparatively less work has been done on the thermal inactivation of enzymes as it relates to heat processed (canned or preserved) fruits. It has been frequently assumed that the heat treatment accorded canned or preserved products in order to destroy microorganisms capable of causing spoilage was more than adequate to destroy enzymes naturally present in the raw material. While this assumption is undoubtedly true in the case of low acid foods, which require a relatively severe process to destroy bacterial spores which may be present, it may not necessarily hold in the case of acid products such as fruits and pickles which are given a relatively mild heat treatment.

In certain products, such as canned citrus juice, a marked deterioration in quality caused by enzymes which survived the process has been recognized and processing procedures have been designed to inactivate the "heat resistant" enzyme as well as to destroy microorganisms. It is conceivable that in certain other products more attention to the thermal inactivation of enzymes would be justified. It is also important in the development of new fruit products that adequate enzyme inactivation as well as destruction of microorganisms be considered.

Since peroxidase is one of the most heat resistant enzymes which are normally encountered in fruits and vegetables, the inactivation of peroxidase has been extensively used as an indication of adequate blanching for fruits and vegetables to be dehydrated or frozen. While it is not definitely known that peroxidase per se is capable of causing undesirable changes in processed foods, it has been generally assumed that if peroxidase is inactivated that other enzymes which can cause undesirable changes will also be destroyed.

If destruction time versus temperature of heating for the enzymes studied are plotted on semilog paper, straight lines result. This held for peroxidase and for ascorbic acid oxidase. Thus true processing conditions for enzymic inactivation in various tissues can be calculated. The same tissue varies from time to time and from place to place, as cucumbers in the same field. Increase of sugar causes greater stability. Increase of acidity causes less stability. Studies on enzymes of fruits, tomatoes and pickles showed peroxidase to be the most heat resistant of the enzymes studied. Ascorbic acid oxidase showed same thermal resistant in tomato juice and peaches.

Destruction of enzymes is important as is the destruction of microorganisms. Much work yet remains to be done to provide a better understanding of the relationship between enzyme and quality retention in canned acid foods.

Discussion

Dr. Pederson reported that apple and grape juices pasteurized at 150° were sterile, but that in a few months they acquired bad flavors, no doubt due to enzymes.

APPLE JUICE AND CONCENTRATES PREPARED WITH ADDITION OF VITAMIN C

by

C. S. Pederson - New York Agricultural Experiment Station - Geneva

This is a process, using ascorbic acid to minimize deterioration by organisms or mold, enzyme activity, and oxidation and thus to enable the marketing of apple juice of improved quality. It was briefly described two years ago. The original method was to put a tablet of ascorbic acid in each bottle or can of juice. In the new process ascorbic acid solution is sprayed on the ground apples before pressing. A satisfactory product was

not obtained when sodium chloride, sulfur dioxide, or mild heating were used to inhibit oxidation. Good sanitation is still necessary; the apples should be chilled, then pressed quickly, and the juice deaerated and pasteurized. Quantities of ascorbic acid varying from one gram to twelve grams per bushel were investigated, six grams was found satisfactory. Three or four grams is sufficient if the juice is pasteurized immediately; with six grams it was held for two hours without change. Color density, at 420 wave length, was used as an index of the deterioration of the juice. Cloudiness of the juice prevents comparisons between different batches of apples. The ascorbic acid treated juice has a light color and a more delicate flavor than conventional apple juice or cider. It has a slight, fine sediment, easily resuspended by shaking. Public acceptance may require education to a taste so different from cider; a uniform blend will also be necessary, based on a study of varieties, maturities, cultural treatments, etc.

As illustrating variations in culture, in an orchard of Baldwins where experiments in fertilization were being made, large variations were found among twelve lots of three bushels each. The juice recovery varied from 59 to 67% by weight, the Brix from 12.5 to 14.6, the pH from 3.24 to 3.50, the total acidity from 0.519 to 0.728, and the viscosity from 1.83 to 2.34 centipoises. In storage until February 7 at 35° F., Baldwins picked in mid October gradually changed in acidity from 0.74 to 0.45%, in pH from 3.18 to 3.52 and in viscosity from 1.71 to 4.88, though no consistent trend in Brix occurred. The ratio of Brix to acidity for different varieties varied widely; in 1947, considering all varieties, it ranged from 16 to 55, averaging 29, in 1948 13 to 31, averaging 23, and in 1949, 15 to 46, averaging 31.5. Certain varieties have typical characteristics; Russets give a very light-colored juice; the juices of McIntosh, Greenings and Delicious darken fast; Wealthy gives a high yield of low-Brix juice.

While there is a real field for a frozen concentrate similar to the present orange concentrate, this requires expensive machinery. The small producer can produce a concentrate by freezing out the water, following in general the method published some years ago by H. C. Gore. Freeze in 30-pound cans at 15° F. for 3 or 4 days; this forms a core of heavy liquid in the center of the can. Drill into this core, invert the cans on a stainless steel rack and let drain 1-1/2 days at 35° F. From 14 cans of McIntosh juice 3 cans of sirup of 39° Brix were obtained, containing 70% of the total solids of the juice. This sirup was refrozen at 15° F. for 3 or 4 days, then a basket centrifuging gave a sirup of 48° to 50° Brix containing 95% of the total solids. By letting the 14 cans drain further at 70° F., using the drainings to wash the mush in the centrifuge, and refreezing, further recovery is obtained. Even if a centrifuge is too costly, good recovery can be had without it. The reconstituted concentrate is indistinguishable from fresh juice by most people.

Perhaps jams or jellies could be made from these concentrates plus sugar sirups. Dr. Hening of our Station has made "fruit ices", using mostly Baldwins to get the tartness desirable in ices. He found that McIntosh concentrate, less tart, made a good ice cream.

In 1948 British Columbia Fruit Processors, Inc., of Kelowne, B. C., sold 130,000 cases of juice made by the ascorbic process for 38 cents/46-ounce can. In New York State a processor using unsatisfactory equipment put up

ascorbic-treated juice; it was light colored but did not retain this light color as well as our own juices.

Discussion

Dr. J. S. Caldwell: How can you get uniform quality? In grape juice, early and late pressings are blended to equalize variation in sugar and acid. Apples vary during the year and from year to year; I found variation of 56% in acid in a 5-year period, some year's having low acid and high sugar.

Answer: Blending is the only remedy. Processors should be aware of differences and try to approach an ideal blend.

Dr. P. A. Wells: We don't know what the ideal blend should be. Any desired juice could be imitated by adding acid, sugar, flavor or pectin.

Dr. J. S. Caldwell: For drinks we need more astringent fruits. Most apples are too sweet.

Dr. C. H. Hills: The acid in apples is 90-99% malic.

R. K. Eskew: Do you think the volatile flavor, the aroma, is improved by ascorbic addition.

Answer: I don't know. I'd like to have the Eastern Regional Research Laboratory try it. Such juice does not have the striking cider flavor which most people at first prefer.

H. C. Aitken: How long does ascorbic hold the light color in pomace? In hammermilled apples?

Answer: If press cloths are filled quickly and kept covered, no appreciable darkening occurs. Instead of the usual steel hammermill we use a Fitzpatrick high-speed hammermill with flat knives; this is made of alloys and stainless steel. This is true of our Fitzpatrick, and I suppose, of yours also.

Dr. L. L. Davis: Some processors prefer adding the ascorbic just before pasteurizing; this gives a partially cider-like flavor and color.

H. C. Aitken: How was viscosity measured?

Answer: By Ostwald pipette, after decanting.

E. Friedman: Did your flavor changes tend to a different character, e.g., quince?

Answer: No.

E. Friedman: Are any varieties of apples undesirable?

Answer: Greenings.

J. J. Willaman: Did you pasteurize the juices?

Answer: Yes.

H. C. Aitken: Have you used the German-type chilled rotating drum, peeling off the ice from its surface?

Answer: No.

Anon: This has been used for orange juice.

UTILIZATION OF FRUIT AND VEGETABLE PROCESSING WASTES

by W. B. Van Arsdel
(Presented by Amon H. Brown - Western Regional Research Laboratory)

The industrial processing of fruits and vegetables by canning or freezing has experienced phenomenal growth during recent years, both relatively and absolutely. Preservation by drying or dehydration, after its mushroom growth during the war, has fallen back once more to a position of minor importance except for raisins, prunes, apricots, and apples. But if all methods of processing be lumped together, the total weight of fruits and vegetables marketed in the United States for processing rose during the 10-year period 1937-1946 from 9 million tons to 15 million tons, and from little more than one-third of the total weight of fruits and vegetables marketed commercially to almost one-half. This was of course, part of the long-time trend toward greater elaboration in the marketing system and the growth of industries based upon the American family's desire for a varied diet at all times of the year, and willingness and ability to pay for both variety and convenience. The wastes that would once have appeared in millions of family garbage pails are more and more being left behind at the processing plants. Being thus concentrated, the waste problem has become both more conspicuous and more challenging.

The same tendency toward centralized preparation, in the interest of household convenience, has also appeared in the fresh-marketing of fruits and vegetables. Particularly in the case of such vegetables as broccoli, carrots, spinach, peas, and lettuce, great tonnages of leafy wastes are left at packing sheds. The Eastern Regional Research Laboratory has developed processes for the economical production of high-grade feeds from such wastes (1)* and is at present engaged in a cooperative commercial evaluation of the processes. The present paper will not concern itself further with this related problem.

If all the processed fruits and vegetables be lumped together, processing plant wastes average at least as much as 30 percent of the total tonnage

* Numbers in text refer to the Bibliography.

of fresh commodities entering the plants--that is, in 1946, at least 4.5 million tons. N. H. Sanborn (2), of the National Canners' Association, has published a tabulation of waste percentages which indicates that the amount varies from as little as 10-12% for snap beans to as much as 85% for sweet corn. This percentage is not, of course, fixed by some law of nature, but is the reflection of current processing standards and current technology. If the American housewife really insists upon perfectly sculptured and uniformly sized canned pear halves, for use in her fruit salads, the canning plant cannot trim off much less than 35% of the fruit. On the other hand, significant reductions in proportion of waste have been achieved by some processing plants through development of improved preparation methods, more careful selection of raw material, better handling of the commodity, and better training of processing line workers.

Better Disposal or Utilization Urgent

The food processing industry, in common with other industries, is finding the disposal of its wastes increasingly difficult and expensive. The problem that was nearly negligible in the day when scattered small canneries operated in rural areas has become great and threatening as the industry has grown and has concentrated in the urban areas. Local, State and Federal regulations prohibiting the casual dumping of liquid or solid wastes now cover the entire nation; some important segments of the food processing industry are operating under temporary suspension of enforcement of such regulations, pending the development and construction of acceptable means of waste disposal. All the evidence indicates that the cost of disposal will be a substantial charge against industry revenues. W. J. O'Connell (3) has estimated for a group of California canneries that the average cost of works which the canner might construct for treatment of usual cannery waste sufficiently to allow discharge to sewers at no additional cost would be $100,000 per 1000 gallons per minute of liquid effluent. Some large canneries discharge several thousand gallons of effluent per minute. In one area in California a projected sewage district would take the entire waste output of several large canneries, solid wastes being disintegrated and added to the sewage, but only at a charge of approximately $2 per ton of total solid wastes.

Under these circumstances there is naturally an intensified search for practical byproduct operations. Whatever organic matter can be removed from the waste stream reduces by so much the cost of disposal, even if the byproduct operation itself only breaks even. If the byproduct more than pays its own way, at least part of the remaining disposal cost is offset.

Characteristics of the Problem

A realistic evaluation of utilization possibilities is not easy, partly because the basic data are sketchy and uncertain. The one pertinent figure that is likely to be known by a cannery manager is the total weight of waste during past seasons' operations; he knows the total weight of raw material that entered the plant and the total amount of finished goods packed--the difference, after applying some reasonably well established conversion factors to the weight of the pack, must have left the plant through the waste streams. But there are at least two such streams leaving every plant--the garbage stream and the sewage stream. Measurement of the weight of dry matter in each, over a long enough period of time

to smooth out fluctuations, would be difficult and expensive. Still more difficult would be a quantitative chemical analysis of those solids. Never, so far as the writer knows, has a real carbohydrate balance or protein balance been determined on a commercial cannery operation. If fruit wastes are flumed with water, how much of the sugar is leached out, to appear in the sewage, rather than the garbage? How much of anything besides insoluble fiber is left with the fine solids recovered from sewage screens and returned to the garbage? The answers to such questions must at least be assumed before an evaluation of the recovery process can be begun. A long, tedious, and expensive research job will be needed to firm up these basic data.

Some of the characteristics of the problem are, however, qualitatively certain. Most of them are difficulties which stand in the way of successful utilization.

In the first place, most solid cannery wastes consist mainly of water. Out of approximately 5 million tons of fruit and vegetable materials which appears annually in the waste streams of processing plants, not more than 600,000 tons comprises all the dry solids--cellulose, sugars, proteins, and minor constituents. Many of the most troublesome solid wastes contain no more than 10% dry solids. Direct drying of such wastes is generally too expensive to be practical, even if it is feasible on other grounds.

Crude estimates indicate that perhaps five-sixths of all the solids in fruit and vegetable processing wastes, that is 500,000 tons, appears in the garbage stream from the plants, the remaining 100,000 tons in the sewage stream. The latter is, of course, greatly diluted, down to a concentration of only a few tenths of a percent solids. The sewage stream presents a disposal problem and nothing else.

The half-million tons of solids in the total garbage waste of fruit and vegetable processing plants is primarily a carbohydrate material--about 300,000 tons of "nitrogen-free extract" (mainly sugars and starch) perhaps 40,000 tons of protein, and smaller amounts of fiber, fats and oils, waxes, organic acids, and other common plant constituents. But lumping the figures together in this way obscures the real problem--and perhaps the opportunity--of any individual processing plant.

Secondly, all of these wastes are extremely perishable--much more so than the fresh fruit or vegetable itself. Enzymic changes proceed rapidly in the cut and bruised tissues. The microbiological population multiplies enormously, even within a few hours, causing rapid loss of potentially useful constituents and frequently forming slimes which make byproduct operations difficult or impossible. Consequently one of the first requisites of a successful utilization process is that the wastes shall be handled like a raw material, not in the way garbage is traditionally handled. The more careful handling will inevitably cost money, and that cost must be charged against the utilization process.

The third characteristic is short-season availability. Like the fruit and vegetable processing plants themselves, the byproduct plant must operate when the harvest comes on. None of the typical wastes is stable enough to be stored for a long-season byproduct operation without the use of preservation procedures, and only under exceptional conditions is such a procedure cheap enough to be considered seriously. The drying

of citrus fruit waste, to serve as a source of pectin, may be one of the exceptions.

The geographical scattering of the processing industry is a fourth element in the problem. If the 4 to 5 million tons of fruit and vegetable wastes all originated in one small area the other problems would not look so formidable. With few exceptions, the promising utilization processes require high-grade technical control and must be carried out on a large scale in order to minimize costs. In general, then, they are not likely to be practical for installation in the typical small cannery. Since hauling the wastes more than a few miles is ruled out in most cases because of spoilage and cost, utilization is most promising where a very large concentration of processing exists in a small area. There are a number of such areas in the United States; for example, in and around San Jose, California, fruit and vegetable processing plants must dispose of more than 100,000 tons of the garbage type of waste during a single season. Most of this waste appears during a period of only three months.

A fifth characteristic of the problem arises from the predominantly carbohydrate constitution of most of the wastes. Even pure sugar, starch, and cellulose are relatively cheap. Insofar as the great bulk of the wastes is concerned, the byproducts seem bound to enter a low-priced market.

This last consideration emphasizes the importance of comprehensive study of the constitution of individual wastes. The generalization about carbohydrates obscures important differences in detail, and the full potentialities of any waste are unknown so long as any important fraction of its constituents remains unidentified.

Some fruit processing operations furnish interesting borderline cases. For example, in a pear cannery the peels and cores at the moment of removal carry flesh that is just as edible as the portion of the pear that is packed. If the juice in this flesh could be recovered, clear and colorless, there is no reason why it should not go into the pack, saving sugar and perhaps adding flavor. This would be a relatively high-valued use, and a number of investigators have worked on it. Logically, however, this edible juice recovery should be regarded as an elaboration of the food processing operation itself, subject to all the safeguards that are thrown around foods. The real waste problem would begin with the disposal or utilization of the residue from the juicing operation.

Examples of Successful Utilization

The production of vinegar from apple cores and peels and the recovery of argols from wine casks have come down to us from pre-industrial days. The list of other successful byproducts of processing operations is short. It includes raisin seed oil, used for oiling the raisins themselves. Dried apple pomace has been used as a source of pectin, as a stock feed, and as an insect bait in insecticides. Dried tomato pomace, for use in mixed stock feeds, has been in and out of the market several times. At least three plants have produced and sold it successfully during the current season. Apricot kernel oil has been produced in California for a number of years. Dried sugar beet pulp is a well established feed constituent.

The most successful large-scale utilization of a fruit waste is undoubtedly that of citrus fruit waste from juicing operations. More than 200,000 tons of dry citrus meal and between 60,000 and 70,000 tons of molasses made from the waste press liquor were produced in a recent year. In addition, more than 100,000 tons of orange peel is used per year for the production of pectin. The citrus meal and molasses have been sold as stock feed, but even in the case of this large development the problems appear not to be completely solved so far as the full acceptability of the feed is concerned.

Recent Research Developments

Laboratories of the Bureau of Agricultural and Industrial Chemistry have made a number of investigations of fruit and vegetable processing waste utilization, and are continuing to work in that field. Jacobs and Newton (4)(5), in the course of a comprehensive analysis of the production of alcohol from farm products, came to the conclusion that fruit processing wastes could not be expected to supply a significant fraction of the demand for industrial alcohol. In addition, the fruit waste can be used only as a supplementary raw material for a nearby alcohol plant primarily based on a dependable year-around source of sugar, such as blackstrap molasses. Pulley and von Loesecke (6) made some of the early investigations which led to the commercial production of citrus meal for feed, and Nolte and von Loesecke (7) reported on the development of grapefruit seed oil. Kester and Van Atta (8)(9), analyzed the possibility of oil production from waste fruit pits, seeds, and nuts. Workers at the Western Regional Research Laboratory (10) described a process for recovering juice from waste asparagus butts and concentrating it to a stable molasses. This product illustrated the kind of advantage that may be realized through knowledge of peculiarities in chemical composition. While the solids were mainly carbohydrates, the protein content (approximate, 6.25 x N) was unusually high (34 percent of the solids), the amino acid composition of the protein was unusual, and in addition the concentrate contained unidentified substances which strongly promoted the growth of certain microorganisms. Asparagus juice concentrate is not being produced commercially, although some of the microbiological industries continue to request samples of the experimental product.

Other workers at the Western Regional Research Laboratory (11) developed a process for the recovery of pure tartrates from winery pomace and brandy still slops. The resumption of imports from Mediterranean countries after the end of the war dissipated the high price incentive which made the process attractive for a time. Maclay and his co-workers in the same Laboratory (12)(13)(14) have developed a series of new uses for citrus pectin which may expand the utilization outlets for citrus waste. Eskew (15), and Howerton and Treadway (16)(17), of the Eastern Regional Research Laboratory have investigated the utilization of pulp and protein water wastes from potato starch plants. Nolte, von Loesecke, and Pulley (18), of the Citrus Products Station in Winter Haven, Florida, described the production of feed yeast or alcohol from citrus waste press juice. Ramage and Thompson (19) reported later developments on the citrus yeast process and also described a process for growing yeast in juice from pear cannery waste which has been developed by Western Regional Research Laboratory workers in cooperation with the Olympia Canning Company, of Olympia, Washington. Humfeld (20), of the Western Regional Research Laboratory,

has described the production of edible mushroom mycelium by a process somewhat similar to the propagation of yeast. Antibiotics (21) and vitamins (22) have been produced in the same Laboratory by fermentation of media containing fruit or vegetable waste juices.

Interest in the large-scale production of yeast for use as food or feed was greatly stimulated by reports on the great German plants which operated successfully during the war. The status of experimental developments in the United States at the present time is not clear. The idea behind them might be stated thus: If a yeast, for example the rapid-growing Torulopsis utilis, is allowed to convert the sugar in a waste juice into yeast substance, cheap inorganic nitrogen in the form of ammonia or its salts can be converted at the same time into protein, so that in effect a low-valued carbohydrate material is converted to a high-valued protein product. But it appears that if the dry yeast must compete in the feed market with the oilseed meals on the basis of its protein content alone, the process will be uneconomic, even if the sugar-containing juice can be delivered to the yeast propagator absolutely free. Relatively small quantities of yeast are being sold at a high price as a source of the B-vitamins, but we do not believe that a new large output of by-product yeast would command this premium price.

During the current canning season the Canners' League of California and research personnel of the Western Regional Research Laboratory have been cooperating (24), in pilot scale tests of the possibility of converting pear and peach cannery wastes into a dry pomace for use as stock feed or land mulch, and a juice concentrate or mollases which can either be mixed and sold with the feed or used for fermentation to industrial alcohol. At the same time workers from the Pullman, Washington, laboratory of the Bureau have been cooperating with the Hood River Apple Growers' Association, Hood River, Oregon, in studies on the recovery of edible juice from pear cannery waste, for return to the pear pack. It is too early to report the results of either of these developments, because evaluation studies on the products are still under way.

Conclusion

One must conclude from all of the foregoing that new byproduct developments from the fruit and vegetable processing wastes will become established--if and when they do--only as the result of unremitting hard work and the best of technical know-how. Casual and ill-informed ventures will only add to the record of expensive failures. It may be that eventually everyone will agree that most of the wastes constitute a disposal problem, pure and simple. But in the meantime, chemists, technologists, and engineers cannot ignore the challenge to produce something useful out of those hundreds of thousands of tons of raw material.

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Discussion

Apropos of Mr. Brown's statement that "molasses made from citrus peel pressed liquors was accumulating faster than it could be sold," Dr. Wells mentioned that this Laboratory had assisted a Florida citrus processing plant in developing a commercial method for producing butyl lactate from citrus molasses. Dr. Wells thought this development offered considerable promise for taking care of the surplus.

Mr. Brown inquired how long it would be before the butyl lactate market was saturated.

Dr. Wells expressed the opinion that he thought the market might well increase with increased availability. One of the conferees commented that to make lactic acid derivatives from citrus molasses might be expected to increase the problem of utilizing dairy byproducts.

RESEARCH NEEDS IN FRUIT PROCESSING

by

E. H. Pfahler, Cherry Growers, Inc.

We in industry realize more and more the necessity of research; not only in processing, but all the way from the variety, culture, and handling of the raw product, to packaging, storage, and distribution. Processing plants are thinking of the cost of research as more or less of an insurance policy.

Experimental results should be practical, something than can be used by all involved plants--large or small. The percentage of plants maintaining a laboratory equipped with the long list of proper apparatus and manned by technical help and supervision is rather small. Granted that every plant should have such a department, at the present they do not. If they do, it is questionable if they could afford everything that is necessary to go with it.

It may be said for the reports given yesterday and today, that they have been on a level which can be understood. Keep all reports on that level -- simplicity will be accepted; complexity will not be accepted. In all fairness to the many small plants throughout the nation, research should aim at practicality of results -- workable results.

One of the problems that has ever been present in the freezing of apples, cherries, peaches, etc., has been that of controlling oxidation, particularly at the top of the package. Thinking now of a 30# tin of any frozen fruit--the top layer or two of fruit undergoes a certain amount of oxidation, while those covered and kept submerged in free liquid, upon defrosting, remain a natural fruit color. Your answer might be to sulfite certain fruits, to blanch or to use certain anti-oxidants. My answer is that none of these procedures are entirely satisfactory. Yes, they will arrest oxidation but in so doing, are destroying the flavor and texture which we so much want to preserve. Apples treated with sodium bisulphite solution

of sufficient strength to prevent oxidation during storage and the defrosting period have a decidedly objectionable taste. Apples that are blanched suffer such tremendous losses of soluble solids and flavor, along with texture changes, that their resemblance to fresh apple slices is discouraging.

The other method of prefreezing treatment is some form of vacuum impregnation. This, to me, comes the closest to what is desirable. I was very much interested this morning in the report given by Mr. Wegener on sirup impregnation of apple slices for freezing. His reference to texture, soluble solids and flavor was very interesting. However, the need for a more desirable procedure remains with me. My reason is, that using ascorbic acid at the rate of 0.2% - 0.3% in the sirup will require probably 15-20 pounds for each 70,000 pounds of product produced. Roughly, on a pack of 100,000 - 30# Tins, this results in a figure of from $7,500 - $10,000. That is a sizeable amount.

As I mentioned, some form of vacuum impregnation is the best method thus far. We do, however, need a brine or a sirup containing some form of non-toxic, tasteless, odorless inhibitor, which will not materially increase the cost of the finished product.

With other fruits, such as cherries, peaches, and apricots, submerging the fruit under a sirup and keeping it there by means of disks has proven quite effective. This, of course, is a necessity with peaches and apricots if a satisfactory product is to be produced. However, such amounts of liquid (6-8 lbs. per 30# Tin) are not too acceptable to the baker. They want fruit and not liquid. This brings up another need in the frozen fruit field -- that of a standardized procedure for determining drained weight.

As a start, suppose we say that we determine drained weights of 30# containers of frozen fruit by defrosting in room temperature of 68° F. until the temperature in the center of the can has reached 30° F., followed by emptying the contents on a previously tared 8-mesh screen of 16 inch diameter and 6 inch depth and draining for two minutes. A procedure which I was informed of last week that is being considered as a standard, would include the pouring of a certain amount of water over the fruit as it rested on the screen, the purpose being to wash off any free sugar or heavy sirup. By catching and weighing the juice and liquid run-off, the drained weight would be determined. Which procedure is used or finally arrived at, in my opinion, is not as important as having one that is universally accepted and used. Buyers should know that, when they are told the drained weight of a 30# Tin of fruit is 22-1/2 lbs., it was obtained by a standardized procedure. In other words, we should be talking, should we say, in the same language. One word of clarification at this point -- it is not the intention here to ask for drained weight standards but only for a procedure to determine the drained weight.

Yesterday, Dr. Marshall gave a very informative talk on spray treatments as affecting the quality of red cherries. This project will, as it should, carry on for several years before arriving at anywhere near a satisfactory conclusion. The results for the 1949 season were entirely different from those obtained in 1948 and observed during the 1947 pack. In 1948 there seemed to be a definite influence on drained weight of canned cherries, on color and soluble solids as affected by maturity, and tanking and

pitting characteristics.

In Wisconsin, I understand the results were the reverse of those in Michigan. That is, in 1949 the same results were obtained as in Michigan in 1948. Why? Several factors, no doubt, are involved and the causes are of vital concern to all processors of red tart cherries.

Let me give you some other related conditions. DDT, parathion, and benzene hexachloride are used on various fruits as controls for certain insects. What is the result? Control is excellent, but how can the spray material be removed? The toxicity of the spray material determines the seriousness of this problem. With benzene hexachloride, the problem arises as to the effect on flavor of the processed product. What other new materials will have the same result?

The time has come when processors are just as interested in their use as growers. Spray recommendations must be based, not only on the efficiency of control and effect on the tree, but, also, on the processing characteristics of the fruit. Can the spray material be removed, is it toxic, does it affect taste, drained weight, soluble solids, etc? These factors should be determined before and not after a recommendation is made. In other words, it is the joint responsibility of the experiment stations, insecticide manufacturers, and food processing laboratories to evaluate each material as to its value.

Various fruit juices are produced and sold to preservers or packed for sale to the housewife. Standards for apple juice call for a Brix of 12° and acidity of 0.35 to 0.7 for Fancy, and a Brix of 11-1/2° and acidity of 0.3 to 0.8 for Standard. Some years such standards cannot be attained, even though the finest quality raw product is used. For instance, records kept by a plant in our area producing apple juice, show that the average acidity computed as malic acid was 0.48, 0.28 and 0.20 in 1947, 1948, and 1949, respectively. If growing conditions are the cause of these fluctuations, the processor can do little in his attempt to produce a standard juice. The problem is that of producing standard juices when the raw product itself is below standard. Some suitable solution would appear desirable.

Growers have thought of processors as an outlet for cull fruit -- a place to dispose of fruit which they are unable to sell on the fresh market. For some time, processors felt the same way and bought off-grade apples, peaches, etc. During the past few years, however, they have begun to realize that the best raw product is none too good -- that the larger apples and peaches result in less peel, core, and pit loss -- that labor costs of peeling and trimming are reduced. There is a trend, then, of processors to ignore, more and more, the offering of poorer quality fruit. This will work a hardship on growers, and processors will have the problem of finding some suitable use for the smaller fruit and that of poor quality, and using them in such a way that labor costs and waste are not too important in their utilization.

In summary, may I repeat that the needs and problems in fruit processing are many. Only a few have been presented. The time has arrived when processors are interested in more than just the processing techniques.

All steps in the flow of a product, which affects the quality of the finished product delivered to the ultimate consumer, are of concern to us. We are desirous of knowing more and more about the variety, how the fruit is grown, the effect of growing conditions on the character of the fruit, and the effect of conditions in distribution channels on the product. All research along these lines must be integrated, as each step is of importance in the economical production of an acceptable product.

Discussion

Dr. L. L. Davis reported that peaches peeled by lye bath still had DDT and parathion in the flesh.

Mr. A. H. Brown said that, in canning pears for baby food, both ends were cut off to avoid spray residue not removed by acid wash.

Dr. P. A. Wells suggested that we look to the edible oil industry for anti-oxidants that might be useful on fruit and vegetables.

Dr. R. R. Legault said that the Western Regional Research Laboratory was studying the nature of oxidases in the hope that it may lead to a rational solution of the browning problem.

DECIDUOUS FRUITS CONFERENCE

Eastern Regional Research Laboratory

February 6 - 7, 1950

LIST OF ATTENDANCE

Name	Organization	Address
Aitken, H. C.	Berks-Lehigh Coop. Fruit Growers	Fleetwood, Pa.
Baker, Geo. L.	Agricultural Experiment Station	Newark, Delaware
Beidler, J. Willis	C. H. Musselman Company	Biglerville, Pa.
Ball, C. Olin	Agricultural Experiment Station	New Brunswick, N. J.
Brice, B. A.	Eastern Regional Research Lab.	Philadelphia, Pa.
Brown, A. H.	Western Regional Research Lab.	Albany, California
Brown, H. D.	Ohio State University	Columbus, Ohio
Caldwell, J. S.	Bureau of Plant Industry, Soils, and Agricultural Engineering, USDA	Beltsville, Md.
Calesnick, Mrs. E. J.	Eastern Regional Research Lab.	Philadelphia, Pa.
Cecil, S. R.	Agricultural Experiment Station	Experiment, Georgia
Chandler, Nathan	---	Sterling Junction, Mass.
Childers, Norman F.	Agricultural Experiment Station	New Brunswick, N. J.
Culpepper, C. W.	Bureau of Plant Industry, Soils, and Agricultural Engineering, USDA	Beltsville, Md.
Darrow, George M.	Bureau of Plant Industry, Soils, and Agricultural Engineering, USDA	Beltsville, Md.
Davis, Jonathan	---	Sterling Junction, Mass.
Davis, Lyle L.	Agricultural Experiment Station	Blacksburg, Virginia
DeCou, Tom	New Jersey Apple Institute	Haddonfield, N. J.
Dryden, E. C.	Eastern Regional Research Lab.	Philadelphia, Pa.
Dutcher, A. W.	Nat'l. Ass'n. of Frozen Food Packers	Washington, D. C.
Eisenhardt, N. H.	Eastern Regional Research Lab.	Philadelphia, Pa.
Ellis, E. A.	---	Castleton, Vermont
Eskew, R. K.	Eastern Regional Research Lab.	Philadelphia, Pa.
Esselen, W. B., Jr.	University of Massachusetts	Amherst, Mass.
Friedman, E.	Welch Grape Juice	Westfield, N. Y.
Garman, Philip	Agricultural Experiment Station	New Haven, Conn.
Getchell, John S.	Agricultural Experiment Station	Orono, Maine
Greeley, Mrs. E. T.	Production and Marketing Administration, USDA	Washington, D. C.
Hand, D. B.	Agricultural Experiment Station	Geneva, New York
Hills, C. H.	Eastern Regional Research Lab.	Philadelphia, Pa.
Homiller, R. P.	Eastern Regional Research Lab.	Philadelphia, Pa.
Howe, Carlton	---	Dorset, Vermont
Ide, L. E.	Production and Marketing Administration, USDA	Washington, D. C.

Name	Organization	Address
Jones, Ivan D.	Agricultural Experiment Station	Raleigh, North Carolina
Krider, M. M.	Eastern Regional Research Lab.	Philadelphia, Pa.
Legault, R. R.	Western Regional Research Lab.	Albany, California
Lewis, F. H.	Pennsylvania State College	Arendtsville, Pa.
Lothrop, R. E.	Eastern Regional Research Lab.	Philadelphia, Pa.
Maclinn, W. A.	Rutgers University	New Brunswick, N.J.
Marsh, R. S.	Agricultural Experiment Station	Morgantown, W. Va.
Marshall, Roy E.	Michigan State College	East Lansing, Mich.
Matchett, John R.	Bureau of Agricultural and Industrial Chemistry, USDA	Washington, D. C.
Morris, R. H., 3rd	Eastern Regional Research Lab.	Philadelphia, Pa.
Myers, Herman	Bureau of Agricultural Economics, USDA	Washington, D. C.
Nelson, Elvin I.	University of Illinois	Urbana, Illinois
Nickerson, J. T. R.	Massachusetts Institute of Technology	Cambridge, Mass.
Nutting, G. E.-	Eastern Regional Research Lab.	Philadelphia, Pa.
Overman, Miss Andrea	Bureau of Human Nutrition and Home Economics, USDA	Washington, D. C.
Oyler, James	Knouse Foods Coop.	Peach Glenn, Pa.
Pederson, C. S.	Agricultural Experiment Station	Geneva, New York
Peters, John	Cooperative Fruit Growers of Adams County	Aspers, Pa.
Pfahler, E. H.	Cherry Growers, Inc.	Traverse City, Mich.
Phillips, G. W. M.	Eastern Regional Research Lab.	Philadelphia, Pa.
Ratchford, W. P.	Eastern Regional Research Lab.	Philadelphia, Pa.
Robert, S. A., Jr.	Bureau of Agricultural Economics, USDA	Washington, D. C.
Rogers, J. S.	Eastern Regional Research Lab.	Philadelphia, Pa.
Rollins, H. A.	Agricultural Experiment Station	Storrs, Conn.
Shockey, H. H.	National Fruit Products Co.	Winchester, Va.
Shutak, Vladimir G.	Agricultural Experiment Station	Kingston, R. I.
Smock, R. M.	Agricultural Experiment Station	Ithaca, New York
Thomas, Frank B.	Agricultural Experiment Station	State College, Pa.
Weckel, K. G.	University of Wisconsin	Madison, Wisconsin
Wegener, John B.	Tennessee Valley Authority	Knoxville, Tenn.
White, David G.	Agricultural Experiment Station	State College, Pa.
White, J. W.	Eastern Regional Research Lab.	Philadelphia, Pa.
Whittenberger, R. T.	Eastern Regional Research Lab.	Philadelphia, Pa.
Willaman, J. J.	Eastern Regional Research Lab.	Philadelphia, Pa.
Woodmansee, C. W.	Agricultural Experiment Station	Newark, Delaware
Wells, P. A.	Eastern Regional Research Lab.	Philadelphia, Pa.